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(RESEARCH ARTICLE)

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Floristic study on some selected paddy fields of Thiruvananthapuram district, Kerala

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Abstract

Agricultural landscapes have attracted increasing attention in connection with the general rise of concern about the conservation of biodiversity. The predominant agricultural land use throughout Asia is paddy farming for the monoculture cultivation of rice. Few studies have examined plant biodiversity in paddy fields. Even though subjected to repeated human disturbance, many plant species persist within the paddy landscape. The present study was undertaken to understand this unique ecosystem by assessing the floristic richness of paddy fields after harvesting the rice to before harvesting rice. The study area located in Thiruvananthapuram District of Kerala. A total of ten fields were randomly selected for the study and five quadrants (1 m x 1 m) were also selected randomly from each field. A total of 44 species were observed belonging to 41 genera of 22 families with Poaceae being the dominant family. Flora on the field proper, bunds and ditch was different. The natives and dicots species out numbered the exotics and monocots respectively, and a gradual increase in the richness was observed from April to July. All species recorded in the field were economocally important. The present study reveals a great diversity of herbaceous plants in the study area. Recent studies shows that wetlands are under more extreme pressure. Threats to wetlands may be natural, manmade or both. Moreover, agricultural practices influenced the species composition. The relation between vegetation and agricultural practices makes an important contribution to the understanding of biological diversity in paddy ecosystems. Further studies are recommended to understood this unique ecosystem and to develop measures for conservation.

Key words: Exotic sxpecies; Poaceae; Post-harvest; Floral diversity; Rice field; Wetland; Ecosystems

1. Introduction

Rice paddies are artificial wetlands rich in biodiversity. According to Nabahungu and Visser [1], wetlands in general are sensitive environments representing some of the most threatened ecosystems having unique properties and values. Paddy fields conserve ground water, provide drainage paths for flood waters and are rich sources of flora and fauna. The rice field ecosystem consists of two morphologically distinct habitats; the rectangular shaped flooded fields on which rice plants grows and the surrounding bunds or levees mainly harboring weeds.

Rice fields, together with their contiguous aquatic habitats and dry land comprise a mosaic of rapidly changing ecotones [2]. In the conventional method of rice cultivation, the fields undergo two different phases, a wet phase followed by a post-harvest dry phase showing a mosaic of habitats. According to Lawler [3], wet phase is similar to a natural temporary wetland. Gaikwad *et al.,* [4], opined that, paddy fields are extremely diversified and possess various plant groups like algae, fungi, bryophytes, pteridophytes and angiosperms. Abandoned paddy fields provide opportunities to restore wetlands and act as substitute habitats for wetland species [5]. Natural restoration of vegetation in abandoned paddy fields is an example of secondary succession [6].

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Globally, rice fields have been well explored successfully for their angiosperm diversity by Begum *et al*., [7], Edirisinghe & Bambaradeniya [8] and Angelina [9]. In India, studies by Prayaga Murty [10], Bhattacharya *et al*. [11], Duary *et al*., [12], Haripal & Sahoo [13], Kavita Sharma *et al*., [14], Kushwaha *et al.*, [15], Yadvinder Singh &Rai Singh [16], Taranisen Panda *et al*., [17], Radhika Kamath *et al.,* [18] and Prabhawati Tiwari *et al*., [19], deal with the post-harvest and floristc diversity of of rice fields.

Nowadays paddy cultivation in Kerala has witnessed a steady decline and the paddy fields converted into land for the cultivation of other crops [20]. Rice fields are habitats that are subjected to periodic, intensive and frequent human activities and natural disturbances and habitats changes throughout the year. Such environmental changes in habitats reflect in flora characteristics also. Most of the biodiversity survey studies were extensive and cover an array of habitats, they do not deal with rice fields exclusively as a habitat. Hence, the present study was undertaken to understand this unique ecosystem by assessing the floristic richness of these fields

2. Material and methods

2.1. Study area

The study area selected was ten randomly selected paddy fields of Thiruvananthapuram District of Kerala. The topography of the area varies from plains to slopes.

2.2. Period of study

Field surveys of the vegetation on paddy field were carried out from after harvesting the rice to before harvesting the rice.

2.3. Data collection and analysis

A total of ten fields were randomly selected from the whole study area. Quadrat method was used as a sampling method [21]. For the determination of the size of the quadrate, species area curve [22] was exercised through which a quadrat of 1 m by 1 m was prepared. Similarly a total of five plots in each field were selected randomly for the convenience of the study. Field surveys were carried out from after harvesting the rice to before harvesting the rice. During the sampling of each plot, details such as name of species and its family were recorded. Every species was photographed and voucher specimens were collected, pressed and mounted on herbarium sheets following standard protocols [23] and deposited in department herbarium.

Field identification was carried out using Gamble [24], Singh *et al.,* [25] and Lakshminarasimhan [26]. The fields were divided into three sections: field proper, bunds and ditch. Separate checklists were made for monthly observations at each field site. All the observed species were then compiled in the form of a checklist. From the compiled list, total number of species, genera and families in the study area during the study period were listed out. The dominant family, variations in the species richness during the period of study, total species under dicots, monocots and pteridophytes, names of weedy plants and exotic plants identified in the study area, total species found in the field proper, bunds and ditch, and abundance of plants in each studied quadrant were listed out. Economic importance of each identified species and IUCN status were also recorded.

3. Results and discussion

The studied rice fields showed surprisingly great biodiversity. A total of 44 plant species were observed belonging to 41 genera of 22 families in the harvested and cultivating paddy fields (Table 1 & 2). Poaceae was found to be the dominant family with 9 species followed by Asteraceae and Cyperaceae with 6 each, and Commelinaceae, Pontederiaceae, Rubiaceae and Salviniaceae with 2 each. The remaining 15 species were representatives of single genus (Figure 1). Out of the total species recorded, 21 were dicots, 19 were monocots and 4 were Pteridophytes (Figure 2). Out of the total number of species, 7 were found only in field proper,14 were found only in bund, 3 were found only in ditch, 15 were found both field proper as well as bund and 5 were found both field proper and ditch (Figure 3). A gradual increase in the species richness was observed from April to July. Of the total number of species a large number flowered throughout the sampling season. By the beginning of May the majority of species completed fruiting and started to disappear.

Table 1 List of angiosperms identified from the study area; F-Field, B- Bund, D- Ditch

Sl.No	Scientific Name of Plant	Common name	Major habitat	Family
1	*Limnocharis flava* (L.) Buchen.	Hermit's waterlily	F,D	Alismataceae
2	*Alternanthera tenella* Colla.	Sanguinaria	F,B	Amaranthaceae
3	*Hydrocotyle asiatica* (L.) Urb.	Gotukola	B	Apiaceae
4	*Lemna minor* L.	Duck weeds	D	Araceae
5	*Ageratum conyzoides* L.	White weed	B	Asteraceae
6	*Blumea mollis* (D.Don) Merr.	Soft blumea	B	
7	*Eclipta alba* (L.) L.	False daisy	F,B	
8	*Elephantopus scaber* L.	Elephant's foot	B	
9	*Emilia sonchifolia* (L.) DC. Ex Wight	Lilac tassel flower	B	
10	*Vernonia cinerea* (L.) Less	Little iron weed	B	
11	*Commelina diffusa* Burm.f.	Climbing day flower	F,B	Commelinaceae
12	*Cyanotis axillaris* (L.) D.Don ex Sweet	Creeping cradle plant	F,B	
13	*Ipomoea sagittata* Poir.	Salt marsh morning glory	F	Convolvulaceae
14	*Cyperus difformis* L.	Small flower umbrella sedge	F,B	Cyperaceae
15	*Cyperus imbricatus* Retz.	Shingle flatsedge	F,B	
16	*Cyperus pumilus* L.	Dwarf sedge	F,B	
17	*Cyperus rotundus* L.	Purple nut sedge	F,B	
18	*Fimbristylis miliacea* (L.) Vahl.	Grass like fimbry	F,B	
19	*Kyllinga nemoralis* (J.Rforst & GForst) Dandy ex Hutchinson & Dalziel	White water sedge	B	
20	*Euphorbia hirta* L.	Hairy spurge	B	Euphorbiaceae
21	*Leucas aspera* (Willd.) Link	Thumbai	B	Lamiaceae
22	*Desmodium triflorum* (L.) DC.	Creeping tick trefoil	F	Leguminosae
23	*Lindernia dubia* (L.) Pennell	Yellow seed false pimpernel	F	Linderniaceae
24	*Ludwigia erecta* (L.) H.Hara.	Primrose	F,B	Onagraceae
25	*Bacopa monnieri* (L.) Ponnell	Brahmi	F,B	Plantaginaceae
26	*Beckmannia syzigachne* (Steud.) Fern.	Slough grass	F	Poaceae
27	*Cynodon dactylon* (L.) Persoon	Bermuda grass	B	
28	*Echinochloa colona* (L.) Link	Jungle rice	F,	
29	*Eleusine indica* (L.) Gaertner	Goose grass	F,B	
30	*Eragrostis japonica* (Thumb.) Trin.	Pondlove grass	F	

31	*Ischaemum indicum* (Houtt.) Merr.	Indian muraina grass	B	
32	*Oryza sativa* L.	Rice	F	
33	*Paspalum distichum* L.	Knot grass	F	
34	*Sacciolepis interrupta* (willd.) Stapf	Interrupted cupscale grass	F,B	
35	*Eichhornia crassipes* (Mart.) Solms	Water hyacinth	F,D	Pontederiaceae
36	*Monochoria vaginalis* (Burm.f.) Kunth	Pickerel weed	F,D	
37	*Portulaca oleracea* L.	Common purslane	B	Portulacaceae
38	*Oldenlandia corymbosa* (L.) Lam	Diamond flower	B	Rubiaceae
39	*Spermacoce exilis*(L.O.Williams)C.D. Adams ex W.C. Burger & C.M.Taylor	Pacificfalse button weed	F	
40	*Scoparia dulcis* L.	Goat weed	B	Scrophulariaceae

Table 2 List of pteridophytes identified from the study area

Sl.No	Name of Plant	Common name		Family
1	*Azolla pinnata* Lam.	Mosquito fern	D	Salviniaceae
2	*Salvinia molesta* D.S. Mitchell	Giant salvinia	D	
3	*Ceratopteris thalictroides* (L.) Brongn.	Water sprite	F, D	Pteridaceae
4	*Marsilea quadrifolia* L.	Pepper wort	F, D	Marsileaceae

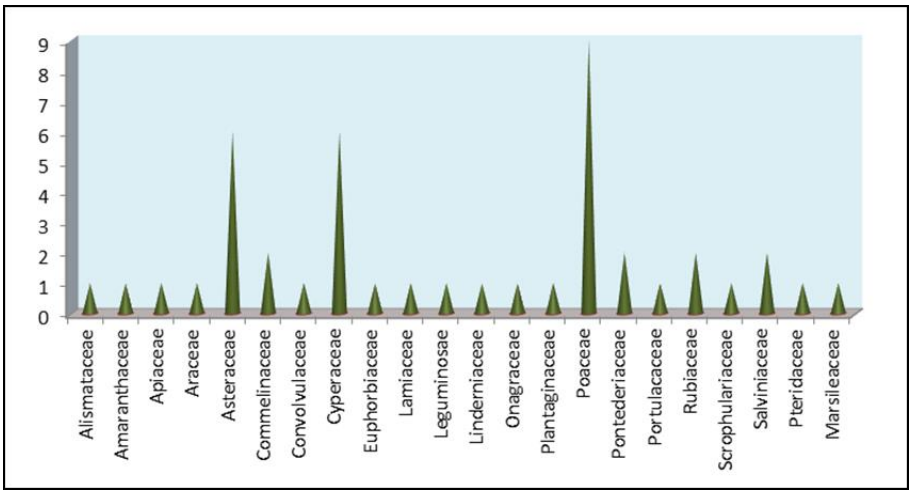

Figure 1 Number of plants identified in each family

All species recorded from the field have varied economic importances. Five plants directly or indirectly used as food in different parts of the world. They are *Limnocharis flava, Ludwigia erecta, Oryza sativa*, *Sacciolepis interrupta* and *Ceratopteris thalictroides.* Young leaves, petioles, flower stalk of *Limnocharis flava* were used as vegetables in many countries, whle leaves of *Ludwigia erecta* are eaten as a cooked vegetable in some countries. Seeds of *Oryza sativa* and *Sacciolepi sinterrupta* are used as food and *Ceratopteris thalictroides* used as a vegetable in many parts of Asia (Table 4).

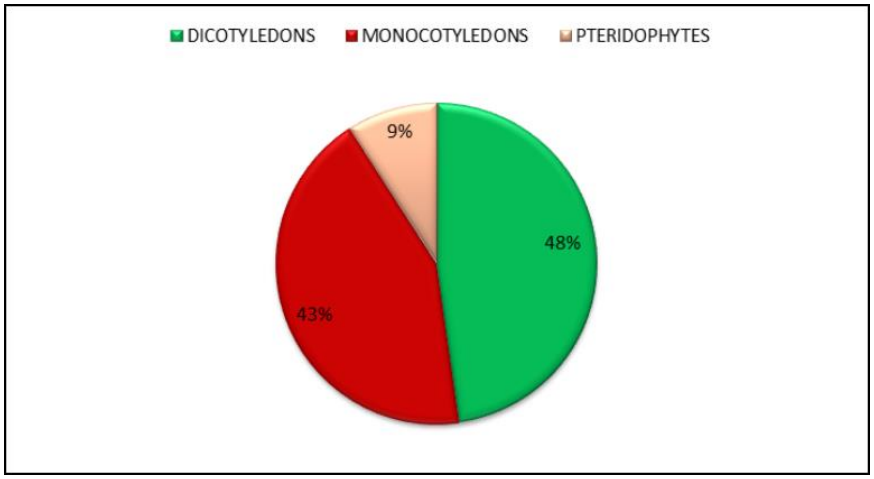

Figure 2 Category of plants identified from the study area

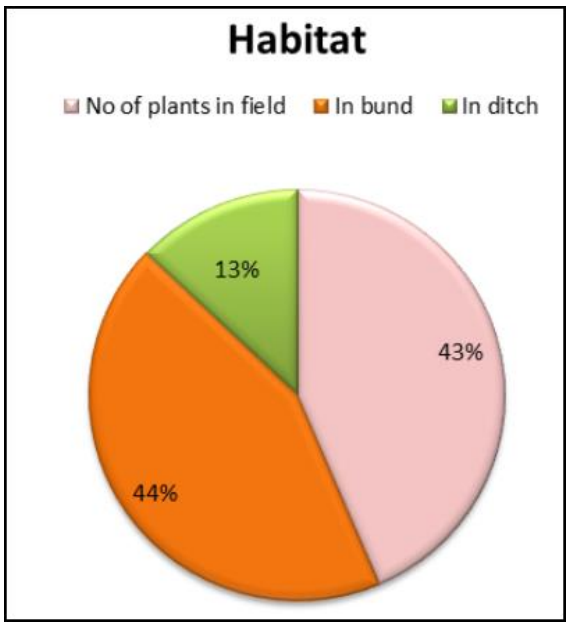

Figure 3 Abundance of plants in each Habitat

Out of 44 plant species, a total of 32 species are used for medicinal purposes. They are used mainly to treat fever, diarrhea, cough, inflammation, pain, burns, diabetes and other skin, eye, liver digestic and respiratory diseases. *Ipomoea sagittata, Leucas aspera* and *Cynodon dactylon* are used against snake bites. *Scoparia dulcis* is used to treat kidney stones, while *Ceratopteris thalictroides* used as an ornamental in aquaria and fish ponds. *Salvinia molesta* used to extract nutrients and pollutants from the water. *Azolla pinnata* is used as a fertilizer in rice production. *Eichhornia crassipes* used for biogas and biofuel production and also used for bioremediation. *Paspalum distichum* and *Echinochloa colona* are used as forage. *Ischaemum indicum, Eragrostis japonica, Fimbristylis miliacea* and *Limnocharis flava* are used as fodder. *Paspalum distichum* and *Beckmannia syzigachne* are used for restoration projects (Table 3). IUCN conservation status of each plant is also listed in the table 3.

Table 3 Uses and IUCN conservation status of plants identified from the study area (NE- Not Evaluated, LC- Least Concern)

Name of plants	**Uses**	**IUCN conservation status**
Limnocharis flava (L.) Buchen.	Young leaves, petioles and flower stalk can be eaten as vegetables. Whole plants are used as fodder.	NE
Alternanthera tenella Colla.	Used in folk medicine to treat fever, infections and genital inflammation	NE
Hydrocotyle asiatica (L.) Urb.	Usedto heal wounds, improve mental clarity and treat skin conditions such as leprosy and soriasis.	LC
Lemna minor L.	Leavesare used homeopathically. Excellent remedy for blocked nose and nasal inflammation.	LC
Ageratum conyzoides L.	Used to treat fever, rheumatism, headache, colic, wounds caused by burns, dyspepsia, eye problems, uterine disorders and pneumonia.	NE
Blumea mollis (D.Don) Merr.	Leaves of the plants have anti-oxidant, anticancer, antibacterial, larvicidal, hepatoprotective, antiin-flammatory properties.	NE
Eclipta alba (L.) L.	Leaf extract is used to treat diarrhea. Root is considerd purgative and used in conditions of liver, spleen and dropsy.	LC
Elephantopus scaber L.	Used as anastringent, cardiac tonic and diuretic.	NE
Emilia sonchifolia (L.) DC.ex Wight	Used as medicine for treatment of gastropathy, diarrhea, opthalmia, nyctalopia, cuts and wounds, inter-mittent fevers, pharyngodyma and asthma.	NE
Vernonia cinerea (L.)Less	Used for the treatment of inflammation, diarrhea, cough, smoking cessation, asthma, parkinson'sd isease and leprosy.	NE
Commelina diffusa Burm. f.	Used to heal swelling, treatment of urinary and respiratory tractinfections and diarrhea, enteritis and hemorrhoids	LC

Out of total of plants, 26 were observed in cultivated fields and 39 were observed in harvested fields. So, 13 species appeared and 5 species disappeared from the field after the harvest of rice. 37 species found as major weedy plants (Table 4). Native species comprised 31 with the remaining 13 species being exotic (Table 5). Abundance of plants observed in each quadrant in the study area were also listed during the study for understanding species richness.

Table 4 List of weedy plants identified from the study area

Sl.No	Name of weedy plants
1	*Limnocharis flava* (L.) Buchen.
2	*Alternanthera tenella* Colla.
3	*Lemna minor* L.
4	*Ageratum conyzoides* L.
5	*Commelina* Burm.f.
6	*Cyanotis axillaris* (L.)D.Don ex Sweet
7	*Cyperus difformis* L.
8	*Cyperus imbricatus* Retz.
9	*Cyperus pumilus* L.
10	*Cyperus rotundus* L.
11	*Fimbristylis miliacea* (L.) Vahl.
12	*Kyllinga nemoralis* (J.Rforst & G. Forst) Dandy ex Hutchinson & Dalziel
13	*Euphorbia hirta* L.
14	*Desmodium triflorum* (L.) DC.
15	*Lindernia dubia* (L.) Pennell
16	*Ludwigia erecta* (L.) H. Hara.
17	*Beckmannia syzigachne* (Steud.) Fern.
18	*Cynodon dactylon* (L.) Persoon
19	*Echinochloa colona* (L.) Link
20	*Eleusine indica* (L.) Gaertner
21	*Eragrostis japonica* (Thumb.) Trin.
22	*Ischaemum indicum* (Houtt.) Merr.
23	*Oryza sativa* L.
24	*Paspalum distichum* L.
25	*Sacciolepis interrupta* (willd.) Stapf
26	*Eichhornia crassipes* (Mart.) Solms
27	*Monochoria vaginalis* (Burm.f.) Kunth
28	*Spermacoce exilis* (L.O.Williams) C.D. Adams ex W.C. Burger & C.M. Taylor
29	*Azolla pinnata* Lam.
30	*Salvinia molesta* D.S. Mitchell
31	*Marsilea quadrifolia* L.

The present study reveals a great diversity of herbaceous plants in the study area. Poaceae are represented by several economic significance species such as *Beckmannia syzigachne, Eleusine indica, 0ryza sativa*, *Cynodon dactylon* and *Sacciolepis interrupta* and other important fodder grasses such as *Echinochloa colona, Eragrostis japonica, Ischaemum indicum* and *Paspalum distichum*. Some species were observed to have acquired a different niche by inhabiting the bunds. The bunds do not undergo the water logged phase similar to that of the field proper.

It is considered that even a slight change in the paddy environment may lead to the extinction of many speces, because their habitat or the number of individuals was limited. Even currently common species in paddy fields could drastically decrease if herbicide use is adopted [27]. Some of the common wetland species in this study site—*Ceratopteris thalictroides* and *Salvinia molesta* are regarded as important for conservation in Japan, where herbicides are widely used in paddy fields [28]. Although wetlands have disappeared at alarming rates throughout the world [29], it is apparent that herbicide- free paddy fields play a role in providing habitat for various wetland plants.

Table 5 List of exotic plants identified from the study area

Sl. No	Name of Exotic plants
1	*Limnocharis flava* (L.) Buchen.
2	*Alternanthera tenella* Colla.
3	*Ageratum conyzoides* L.
4	*Ipomoea sagittata* Poir.
5	*Euphorbia hirta* L.
6	*Lindernia dubia* (L.) Pennell
7	*Ludwigia erecta* (L.) H.Hara.
8	*Paspalum distichum* L.
9	*Eichhornia crassipes* (Mart.) Solms
10	*Portulaca oleracea* L.
11	*Spermacoce exilis* (L.O.Williams) C.D. Adams ex W.C. Burger&C.M.Taylor
12	*Scoparia dulcis* L.
13	*Salvinia molesta* D.S. Mitchell

Wetland plants are at the base of the food chain and are a major source for energy flow in the ecosystem. The primary productivity of wetland communities varies, but some herbaceous wetlands have extremely high levels of productivity, even more than that of tropical rain forests. The composition of the plant community and the predictable changes in community structure that result from anthropogenic disturbance are being investigated for their ability to act as biological indicators of ecological integrity of the wetland [30]. This kind of information has many potential applications including monitoring wetland condition over time or setting goals for wetland restoration and mitigation projects. According to Brinson [31] wetland plants are often used to help organize environmental inventories and research programs, and to set goals for management programs or restoration projects.

Elphick [32] opinioned that, in regions where natural wetlands are threatened due to anthropogenic activities, rice fields present a potential surrogate habitat for wetland taxa. Although the flooded rice fields cannot be considered equivalent to natural wetlands. The factors contributing to high species diversity in paddy fields are the presence of species unique to different paddy types; the presence of remnant species from original vegetation; and the impact of agricultural practices [33]. Many of the common wild species in fields in this study site were also common in many other areas [34]. On other hand, other species that were dominant in our study site, (*Eragrostis japonica, Cyperus rotundus, Lindernia dubia, Monochoria vaginalis, Eleusine indica* and *Limnocharis flava*) were not recorded in many other studies. Zhao *et al.,* [35] have shown that paddy field weed biodiversity can be improved by the combined application of organic and inorganic fertilizers compared to a single inorganic fertilizer.

Naturally occurring plants along the borders of paddy fields provide a stable habitat and abundant food for parasitoid wasps and other predatory natural enemies. The paddy fields in this study site contained fields aged from 10 years to more than 10 years, and remnant species were recorded even on the levees of the older fields. According to Herlinda *et al.,* [36] more diverse vegetation tends to have higher species diversity. This could happen because there had been seeds scattered and distributed in the land. This is supported by Nicholls and Altieri [37] that weeds are plant community constructing ground stratification. According to the present survey and field observation, water buffaloes and cattle

grazed almost all herbaceous species. Other kinds of impacts occurred site specifically with different frequency and intensity.

4. Conclusion

In the present study sites, fields comprised not just a homogenous landscape producing merely rice, but also harbored many plant species, including exploited species, beneficial species and rare species. In the present study, a total of 44 species were observed belonging to 41 genera of 22 families in the harvested and cultivating paddy fields. In Kerala, wetlands are under more extreme pressure compared to any other State, which is attributed to relatively very high population density. Studies carried out in recent year's to point out the undesirable changes taking place in the geological, physical, chemical and biological environment of the wetlands of Kerala. This kind of analysis of the interaction between vegetation and agricultural practices makes an important contribution to the understanding of biological diversity in human-managed ecosystems. Further studies are recommended to understood this unique ecosystem and develop measures to conserve them.

Compliance with ethical standards

Disclosure of conflict of interest

Authors state no conflict of interest.

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